U.S. Department
of Transportation

Federal Aviation Administration

Memorandum

Subject: **ACTION**: Review and Concurrence, Equivalent Level of Safety Finding for Cessna New Model 680
FAA Project #TC2548WI-T

Date: April 28, 2004

Reg Ref: §§ 25.857, 25.1195

From: Manager, Propulsion/Mechanical Systems Branch, ANM-112

Reply to Attn. of: Bob Adamson, ACE-118W

To: Manager, Wichita Aircraft Certification Office, ACE-115W

ELOS Memo #: TC2548WI-T-P-5

Background

The Model 680 Sovereign design includes a fire extinguishing system for a Class C baggage compartment that can also be used for fire extinguishing of the APU (non-essential, flight operational) installation. This is accomplished by adding the necessary plumbing and valves between the single high discharge rate Halon bottle of the baggage compartment fire extinguishing system and the APU fire extinguishing system. When the single high discharge rate bottle is discharged to either the Class C baggage compartment or APU installation, the bottle is left empty. As a result, the other compartment is without fire extinguishing capability for the remainder of the flight.

Applicable regulation(s)

Sections 25.601 – Design and Construction, General, 25.851(b) – Fire extinguishers, 25.901 – Powerplant, Installation, 25.857 – Cargo compartment classification, 25.1195 – Fire extinguishing systems, 25.1301 – Equipment, Function and installation, and 25.1309 – Equipment, systems, and installations.

Regulations requiring an ELOS

Sections 25.857 – Cargo compartment classification and 25.1195 – Fire extinguishing systems

Description of compensating design features or alternative standards which allow the granting for the ELOS (including design changes, limitations or equipment need for equivalency)

1. The APU and the Baggage Compartment have separate fire/smoke detection systems. No failure or malfunction in one system can adversely affect function of the other.
2. The APU provides bleed air for cabin heating and cooling, but is isolated from the baggage compartment heating system by a check valve. Any fire originating in the APU compartment will be isolated to that compartment by the firewall and the APU bleed air shutoff valve.

3. The APU and the Baggage Compartment have no common wiring. No single electrical fault can cause a fire in both compartments.
4. The shared fire bottle, it's plumbing and controls are entirely outside the APU rotor non-containment zone. An APU rotor non-containment will not affect the APU compartment fire protection system.
5. The baggage compartment is entirely outside the APU rotor non-containment zone. An APU rotor non-containment will not cause a fire in the baggage compartment, which could necessitate fire extinguishing in both compartments.
6. The baggage compartment is in the engine rotor non-containment zone. The APU compartment is entirely outside the engine rotor non-containment zone. An engine rotor non-containment can not cause an APU compartment fire.
7. The probability of either a baggage compartment fire or an APU fire is Remote. The probability of a fire protection system failure is 1E-5. Consequently, the probability of an uncontrolled fire on the same flight in either compartment is Extremely Improbable.
8. There are no common cause failures that could result in a simultaneous baggage compartment fire and APU fire.
9. There are no shared cockpit controls. Each system is provided with separately located, appropriately labeled controls. The only shared annunciation is the Baggage/APU fire bottle low indication. In the event of a Baggage/APU Fire Bottle Low message, both the baggage compartment heat and APU systems will be rendered inoperative. The APU will be inoperative and the baggage compartment heat shut-off valve will automatically be commanded closed.
10. The shared bottle is provided with two separate discharge fittings and squibs. Each squib has a dissimilar electrical connector, which prevents electrical cross-connection. The bottle mounting and discharge fitting arrangement is deliberately asymmetric, which prevents mechanical cross-connection of the two systems.
11. While the probability of a baggage compartment fire and APU fire on the same flight is Extremely Improbable, AFM procedures specify that the APU not be operated if the baggage compartment fire extinguisher has been fired. In the event the bottle is fired for either a baggage compartment fire or APU fire, AFM procedures specify to land as soon as possible at nearest suitable airport.

In addition, for the baggage compartment fire suppression duration capability, Cessna will utilize a Halon quantity that provides for adequate suppression concentration for a time duration determined and demonstrated by flight test and analysis.

The AFM procedures include a limitation that reads: "To ensure cargo fire protection, flight must be within [specified time] of a suitable airport for landing whenever cargo is carried" or similar wording.

Where the specified time is less than or equal to the minimum extinguishing concentration (3% metered) duration for the airplane's FAA approved configuration.

Explanation of how design features or alternative standards provide an equivalent level of safety intended by the regulation

The Smoke Detector Installation consists of two (2) smoke detectors, one each located in the two upper lobes of the baggage compartment, that provide outputs to the cockpit EICAS and the Baggage Compartment Heat Shut-Off Valve. Preflight test of the smoke detectors is provided by operation of the rotary test switch, which tests the smoke detectors for internal faults and actuates the baggage fire annunciations. Both smoke detectors must successfully test to provide the baggage fire annunciations.

When smoke is detected by either detector, the Master Warning indicator on the flight control panel is illuminated, a double chime is sounded, the red "BAGGAGE FIRE" fire bottle control switch is illuminated and a red "BAGGAGE FIRE" message appears on the EICAS. The smoke detectors also remove power from the Normally Closed (N/C) Baggage Compartment Heat Shut-Off Valve, causing it to close, to shut off airflow into the compartment. The "BAGGAGE FIRE" EICAS message and "BAGGAGE FIRE" fire bottle control switch will remain illuminated and power will be kept from the valve as long as either smoke detector continues to detect smoke. If the Baggage Compartment Heat Shut-Off Valve fails to close, the position switch located on the baggage heat shut-off valve will remain open, causing illumination of a amber "BAG HEAT SHUTOFF FAIL" EICAS message. The crew must then manually select Baggage Heat OFF. If this fails to extinguish the "BAG HEAT SHUTOFF FAIL" EICAS message, the crew must then select the left Environmental Bleed Air Flow Control Valve OFF, which shuts off flow upstream of the Baggage Compartment Heat Shut-Off Valve. However, the crew would have already performed these procedures as part of the “BAGGAGE FIRE” EICAS message.

If both smoke detectors stop detecting smoke, the annunciations will remain illuminated and power will be kept from the valve for an additional five seconds. This is done so that any intermittent smoke detect signal sufficient to actuate the Master Warning will also cause the other annunciations to be held on long enough for the crew to see the source of the Master Warning .

The Fire Suppression Installation consists of two (2) Fire Extinguisher Bottles, discharge plumbing and nozzles and a cockpit control switch. The bottle assemblies are charged with Halon 1301 (Bromotrifluoromethane, CF_3Br) extinguishant and pressurized nitrogen propellant. They each consist of a pressure vessel with a temperature compensated pressure switch (TCPS), a fill port, an over-pressure relief valve, a metering device for control of extinguishant flow, a discharge fitting and an electrically actuated pyrotechnic discharge cartridge.

In normal operation, bottle pressure is monitored by the TCPSs. If the propellant pressure in either bottle falls below the switch setting, a cyan "BAGGAGE FIRE BOTTLE LOW" EICAS message will be displayed.

To discharge the bottles, the copilot must lift the switch guard and actuate the "BAG COMP FIRE" switch, located on the right side of the copilot's instrument panel. This fires the cartridge in the High Discharge Rate (HDR) bottle. The extinguishant quantity in the HDR bottle, 2.5 lb., is adequate to achieve a concentration in an empty baggage compartment (most critical) of at least 5% for 0.5 seconds. The HDR bottle is equipped with a metering device on its outlet fitting, to control the discharge time to 4±1 seconds. After a time delay, the Metered Discharge Rate (MDR) bottle will be automatically fired.

Extinguishant from the two bottles will be routed to the baggage compartment through plumbing to two discharge nozzles, one located in each lobe of the baggage compartment. Geometry of the discharge nozzles maximizes the uniformity of extinguishant concentration throughout the compartment for all feasible loading conditions.

The HDR bottle is also used for APU fire extinguishing. It is provided with an additional discharge fitting and pyrotechnic discharge cartridge. Controls and plumbing for the baggage compartment and APU fire protection systems are separate. Electrical connections for each cartridge on both bottles are dissimilar and plumbing and mounting bracketry are arranged so that the two systems can not be crossed-connected.

FAA approval and documentation of the ELOS

The FAA has approved the aforementioned Equivalent Level of Safety Finding in Issue Paper P-5. This memorandum provides standardized documentation of the ELOS that is non-proprietary and can be made available to the public. The Transport Directorate has assigned a unique ELOS Memorandum number (see front page) to facililitate archiving and retrieval of this ELOS. This ELOS Memorandum Number should be listed in the Type Certificate Data Sheet under the Certification Basis section. [E.g. Equivalent Safety Findings have been made for the following regulations: § 25.857 – Cargo compartment classification and § 25.1195 – Fire extinguishing systems (documented in TAD ELOS Memo TC2548WI-T-P-5)]

/s/

Signature: Neil D. Schalekamp
Manager, Propulsion/Mechanical Systems Branch, ANM-112

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ELOS Originated by Wichita ACO:	Program Manager, Tina Miller	Routing Symbol ACE-117W